



AN EMPIRICAL STUDY ON PUBLIC AND PRIVATE CAPITAL FORMATION IN THE AGRICULTURAL SECTOR OF INDIA

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ABSTRACT

Background: Indian agricultural sector plays a crucial role in country's economic growth, employment generation, and exports. Globally, India holds the second largest land holdings. Although, both public and private capital formations have risen manifold, the contribution in country's GDP is still hovering around 3 percent. The present study aims to empirically examine the impact of both public and private investments on the growth of agricultural sector by using Autoregressive Distributed Lag model (ARDL). The study reveals that private investment in the agriculture sector has increased drastically in the post reform period. The study found no cointegration between both public and private capital formations on agriculture growth however, the lagged values of agricultural share in country's GVA as well as lagged values of private investment positively and significantly impacts agricultural growth while public investment shows insignificant in influencing agricultural growth. The study suggest that government should increase public investment in major projects so as to endorse more private investment in the agricultural sector which will further raise the agricultural productivity and sustainability.

KEYWORDS: Public Capital Formation In Agriculture, Private Investment In Agriculture, ARDL, GVA

JEL Classification: Q10, Q14, C5

1. INTRODUCTION

Globally, India is one of the key players in agricultural sector. Indian agriculture and allied sectors are a mainstay for above 55 percent of the Indians who depends on the sector for their livelihood. The sector contributes only 18.8 percent in India's GVA (2021-22), generates around 50 percent of employment opportunities and accounts for US\$ 43.37 billion in India's total exports (FY2023). The country has the largest cattle herd, second largest producer in horticulture, wheat, rice, sugarcane, cotton tea, farm fish worldwide. It has the second largest agricultural land holdings. The farmers engaged in cultivating various crops and other allied activities like rearing livestock and fishing in various agro-climatic conditions and terrains. However, the sector depends on the whims of monsoon due to poor infrastructure and irrigation facilities. For a sustainable growth and development of Indian economy, revival of agricultural and allied sector is important and therefore, investment in this sector is the pre-requisite to enhance the productivity and quality of the rural assets. The sector can be profitable and contribute more to Indian economy if both public and private capital formation will be raised in upgrading technology and infrastructure development such as hybrid seeds, fertilisers, machineries, irrigation facilities and promoting organic farming and enhancing marketing facilities.

Capital formation by the government consists of investment in irrigation facilities such as building wells, dams etc., electricity supply, reclamation of land from watershed area, development of well, rural infrastructure, warehouse and cold storage facilities, farm supplies, agricultural research and development, education and training, access to fertilizers, tractors and other machineries and equipment. While private investment can be done in building irrigation facilities, farm buildings, farm mechanization, land development and reclamation, organic farming, vertical farming, development of plantation and horticulture, food processing, technological development,

warehousing, and transportation facilities. Both public and private capital formation are complementary for the development of the agricultural sector.

The new development in India in cloud seeding is an important development for the country which will help the farmers to boost agricultural productivity by lessening the dependence on monsoon. However, the technology requires huge investment.

1.1 Importance of Public and Private Capital Formation in Agriculture and Allied Sector:

The development and sustainability of the agricultural sector requires huge capital investment. Hence, both public and private capital formation plays a fundamental role in agricultural sector of India.

1.1.1 Public Capital Formation in Agriculture and Allied Sector:

The Government of India plays a crucial role in developing the agricultural sector by providing the public capital formation through various schemes, infrastructure development and subsidies.

Government Investments: The government introduced various schemes to develop the agricultural sector such as Rashtriya Krishi Vikas Yojana (RKVY), Pradhan Mantri Krishi Sinchai Yojana (PMKSY), Paramparagat Krishi Vikas Yojana, Gramin Bhandaran Yojana for Rural Godown Scheme, Pradhan Mantri Kisan Maan-Dhan Yojana (PM-KMY) is a pension scheme, Micro Irrigation Fund (MIF) Electronic National Agriculture Marketing (E-NAM), National Mission for Sustainable Agriculture and many more. The government invested in infrastructural development such as rural roads, creation of well, irrigation and cold storage facilities, providing hybrid seeds at a subsidized rate etc.

Research and Development: For agricultural research and development huge public funding needed. Indian Council of Agricultural Research (ICAR) help farmers adopt modern farming techniques by promoting research and development in agricultural field.

Rural Development Programs: Agriculture and allied sectors are the mainstay of above 50 percent of the Indian people. The rural development programs help to enhance the socio-economic conditions of the rural people which requires public capital formation in agricultural and allied sectors.

Crop Insurance: Agricultural sector mainly depends on the vagaries of monsoon and there are frequent crop failures due to poor monsoon, flood, drought, and natural disasters and hence, there is increase in the number of farmer suicides. Government sponsored crop insurance schemes like Pradhan Mantri Fasal Bima Yojana (PMFBY) protect the farmers against any crop losses. Therefore, the sector requires government funding to safeguard our farmers.

Subsidies: The promote the agricultural and allied sector and foster private investment, government provide subsidies on seeds, fertilizers, tractors, irrigation, and other equipment. Subsidies help the farmers to get agricultural inputs at more affordable prices.

Credit Facilities: To support agricultural financing, the public sector banks offer agricultural credit at a concessional rate which encourage the farmers to invest in their farms. Institutions like National Bank for Agriculture and Rural Development (NABARD) support agricultural financing.

1.1.2 Private Capital Formation in Agriculture and Allied Sector:

Private Sector Investments: Since 1990 economic reforms, private capital formation both private and foreign companies play a crucial role in farm sector. They invest in R&D, seeds, fertilizers, machine and equipment, pesticides, and irrigation systems to enhance the agricultural productivity.

Access to Credit: Private banks and other private financial institutions also provide credit to the farmers to meet farm expenses and infrastructural development.

Farm Mechanization: Private sector also invests in farm machines and equipment such as purchase of tractors, harvesters, and irrigation systems that enhance farm productivity.

In agricultural sector, capital formation is a pre-requisite for sustainable growth and food security of the country. Public capital formation in rural infrastructure development and support systems like minimum support price, government procurement etc helps to create a conducive environment for private investments and ensures equitable development across the regions while private capital formation drive innovation and efficiency. The present study aims to investigate the effect of both public and private investment on economic growth of the country.

1.2 Objectives

The key objectives of the present study are as follows:

1. To make a trend analyse of both public and private capital formation in Indian agricultural sector.
2. To empirically investigate the effect of public capital formation on Indian economy

3. To examine the effect of private capital formation on Indian economy

1.3 Trend Analysis - Gross Capital Formation in Agriculture & Allied Sector:

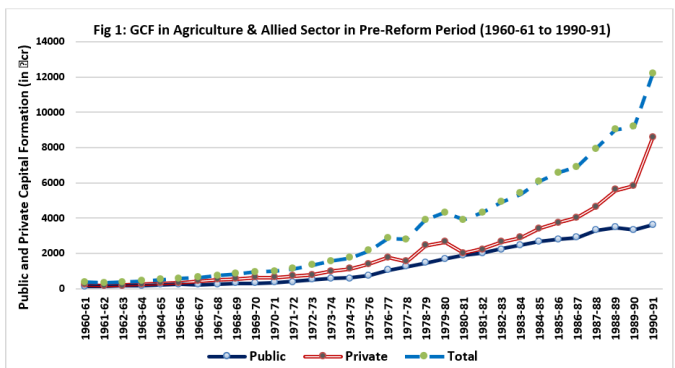
A trend analysis will provide an overview of both public and private capital formation in agriculture and allied sector. Figure 1 & 2 shows the gross capital formation in both pre and post reform periods:

Year	GCF_Pub_Sec	GCF_PvtSec	Total_GCF	agri_share_GVA	Total_GVA
1970	309	634	943	475749	903636
1971	348	644	992	505790	962522
1972	404	724	1128	536361	1010777
1973	525	808	1333	527892	1020982
1974	588	993	1581	505371	1017730
1975	614	1138	1752	539480	1064051
1976	745	1420	2165	533787	1076403
1977	1057	1781	2838	602278	1173327
1978	1258	1536	2794	571756	1187992
1979	1452	2446	3898	625860	1276734
1980	1687	2623	4310	640471	1346987
1981	1892	2018	3910	565623	1276924
1982	2041	2263	4304	638166	1368481
1983	2263	2636	4899	672702	1445465
1984	2466	2902	5368	678705	1487737
1985	2678	3413	6091	742154	1604580
1986	2818	3768	6586	753609	1668141
1987	2895	4033	6928	759861	1737565
1988	3304	4642	7946	766830	1812537
1989	3442	5577	9019	759447	1876600
1990	3354	5833	9187	878715	2067262
1991	3628	8596	12224	896069	2194056
1992	3653	9000	12653	939527	2310015
1993	4175	10804	14979	927985	2343059
1994	4918	10331	15249	982118	2468738
1995	6002	12381	18383	1012169	2608995
1996	6762	14605	21367	1066097	2775834
1997	7296	17119	24415	1068399	2978143
1998	6921	19087	26008	1159707	3215638
1999	7583	19131	26714	1149580	3353964
2000	8670	41481	50151	1216189	3578123
2001	8176	38558	46734	1251357	3864524
2002	10353	51285	61638	1255564	4024831
2003	9563	52319	61882	1323123	4241595
2004	12218	49249	61467	1264769	4406074
2005	16187	59909	76096	1365910	4757084
2006	20739	69203	89942	1385053	5092503
2007	25606	75496	101102	1454707	5514228
2008	27638	95679	123317	1501776	5958367
2009	26692	133655	160347	1582155	6398296
2010	33201	151325	184526	1572216	6674215
2011	31968	165396	197364	1576526	7131837
2012	35696	238175	273870	1728167	7704514
2013	39743	233747	273490	1762983	8106946
2014	40827	290009	330836	1786897	8546275

2015	47319	284545	331863	1872305	9063649
2016	56167	242388	298555	1894400	9712133
2017	66895	281529	348424	1934120	10491870
2018	66916	295790	362706	2075252	11328285
2019	80077	331357	411434	2169635	12034171
2020	72308	360158	432466	2205413	12733798
2021	87759	437114	524873	2304069	13219476

Source: Author's estimation based on NSO data

1.3.1 Gross Capital Formation in Agriculture & Allied Sector in Pre-Reform Period (1960-61 to 1990-91)

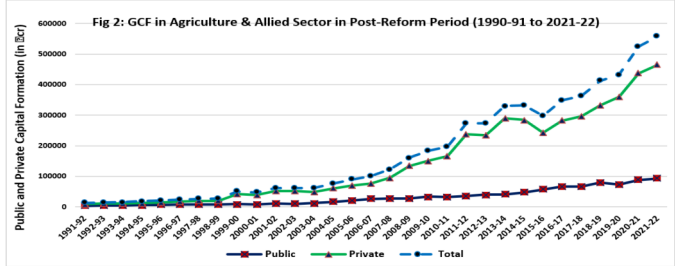


Source: Author's estimation based on NSO data

Figure 1 reveals the gross capital formation in agriculture and allied activities by government, private and total investment during pre-reform period (i.e., 1960-61 to 1990-91). Figure clearly indicates that in pre-reform period both public and private investment in agricultural and allied sector was very low i.e., below ₹2000 crore till 1977-78 and both public and private investments remain almost constant. Although, since 1980-81 both public and private investments take off, but private investment were higher than public investment and private investment reached to ₹8596 crore while public investment increased till ₹3628 crore.

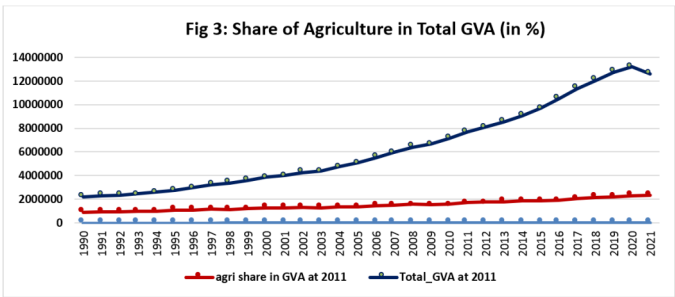
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1.3.2 Gross Capital Formation in Agriculture & Allied Sector in Post-Reform Period (1990-91 to 2021-22)



Source: Author's estimation based on NSO data

Figure 2 reveals that after the economic reforms both the public and private capital formations have increased in absolute terms i.e., public sector GCF has increased from ₹3653 crore to ₹93225 crore i.e., at a Compound Annual Growth Rate (CAGR) of 11.02 percent while private investment has raised from ₹9000 crore to ₹464344 crore i.e., CAGR of 13.57 percent during 1990-91 to 2021-22 in agricultural and allied sector. Overall, total gross capital formation in the sector has also increased at a CAGR of 13 percent. The study concludes that economic reform of 1991 has opened up Indian market for privatisation and globalisation and hence, private investment has drastically increased in post reform period.



Source: National Statistics Office (NSO)

Figure 3 shows the agriculture share in GVA and total GVA in India at 2011-12 prices. It clearly reveals that agriculture share in total GVA has increased at a CAGR of 3.05 percent in post reform period i.e., Rs. 896069 crore in 1991 to Rs. 2342056 crore in 2022. It indicates that post reform period the agricultural share in country's gross value added has remain constant. Hence, to boost the agricultural share in country's GVA, the need is to increase the capital formation to enhance the agricultural productivity which still has immense opportunities.

2. LITERATURE REVIEW

Kumar, Bathla, & Verma (2023) attempts to analyse the temporal and spatial trends of private fixed capital formation and their compositions in agricultural sector as well as its relationship with public investment. The study found there was considerable increase in private investment in agricultural sector since 2000 except few States in India like Himachal Pradesh, Orissa and J&K. Higher investment was found in land enhancement, farm mechanization like purchasing tractor, and livestock farming while public investment was shown high in irrigation facilities especially in low- and middle-income States. Arslanalp, Bornhorst, Gupta, & Sze, (2010) in an IMF working paper have investigated the effect of public investment (capital) on economic growth of 48 OECD and non-OECD countries for the period between 1960 to 2001. They used production function and reveals direct but concave output elasticity with regard to public capital. The study also found effect of public investment on economic growth was substantially high when longer intervals were taken into account for non-OECD countries.

Chand (2010) in a book chapter have conducted a trend analysis of both public and private capital formation in agricultural sector for 25 years and the factors affecting the capital formation. The study found negative impact of subsidies on public investment and economic reform had negatively impacted public capital formation and subsidies in agricultural sector as share of GNP. The study suggested public investment is important to revive the agricultural sector.

Government's endorsement to agriculture and allied sector reinforced the farmers to make private capital formation in the

sector which further accelerate agricultural growth. A direct relationship has been found between public and private investments which indicates higher public capital formation crowd-in private capital formation in agriculture sector. In tandem, higher public investment in infrastructure development, education and health of the farmers may have “inducement Effect” on private investment by enhancing the agricultural productivity (Bahal et al. 2018; Mitra 2006). Few studies found strong relationship between two investment sources in agricultural sector during 60s to mid-90s which includes public capital formation in building and linking canals along with private investments in developing high yielding varieties (HYV) seeds and minor irrigation facilities which led to higher crop production (Dantwala 1986, Shetty 1990, Dhawan 1998, Chand 2000, Gulati & Bathla 2001). However, a weakening relationship was found during mid-80s and 90s due to stagnant public investment in irrigation systems. Mishra and Chand (1995) in their study countered the “Complementarity Hypothesis” in the long run. However, their study was limited due to lack of government data on public investment, which were limited for major and medium irrigation facilities but not minor. Although, the share of public investment in agriculture and allied sectors had constantly declined from 50% in 1960s to 15% in 2010s but the relevance of public capital formation in agriculture sector remains unquestionable (Fan & Hazell, 1999; Fan 2008; Bathla 2017).

3. RESEARCH METHODOLOGY AND DATA SOURCE

The research design used in this is quantitative research approach based on secondary data sources collected from RBI Statistical Handbook and National Statistical Office. To examine the impact of both public and private capital formation on agricultural growth, the study used Autoregressive Distributed Lag (ARDL) model. The model is used to analyse dynamic timeseries data when the number of observations are less and when the data is stationary either at first differencing i.e., I(1) or a mix of I(0) and I(1). The equation is as follows:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \dots + \beta_p Y_{t-m} + \alpha_0 X_t + \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \dots + \alpha_q X_{t-n} + \varepsilon_t \quad \text{.....Equ. 1}$$

Where, m and n are the numbers of lagged years; α_i is the long run coefficients; β_i is the short run coefficients and; ε_t is the disturbance terms.

4. RESULTS AND DISCUSSION

To empirically investigate the effect of public and private capital formation on the share of agricultural gross value added (GVA), the study used Autoregressive Distributed Lag (ARDL) model in a multivariate time-series data for a period between 1970 and 2022 with the help of STATA. The dependent variable used in the study is the share of agricultural GVA and independent variables are public and private gross capital formations. The descriptive statistics has been shown in Table 1:

Variable	Obs	Mean	Std. Dev.	Min	Max
year	53	1996	15.44345	1970	2022
gcf_pub_sec	53	18962.68	25448.1	309	93226
gcf_pvtsec	53	87086.74	127887.7	634	464344
total_gcf	53	106049.4	152937.8	943	557570
agri_share~a	53	1156734	547578.5	475749	2342056
total_gva	53	4335901	3659046	903636	1.32e+07

Source: Authors' estimation

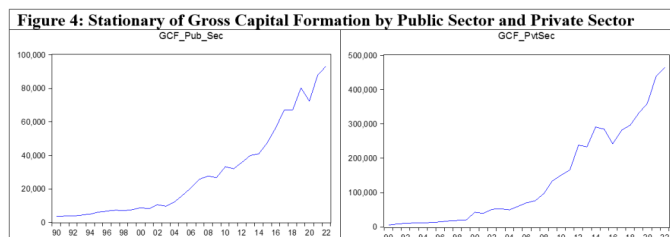
Table 2: Descriptive Statistics

Table 2 clearly reveals that the total number of observations is 53 years and the mean share of public and private sector gross

capital formation in agriculture is Rs. 18962.68 crore and Rs. 87086.74 crore respectively where the mean share of agricultural and allied sector in countries GVA is Rs.1156734 crore and the mean of total country's GVA is Rs. 4335901 crores.

4.1 Stationary Check

Initially, unit root test has been conducted to test the stationarity of the variables using Dickey Fuller test (DF) and found that all the variables are non-stationary at levels as shown in Figure 4 and hence, shows trends. We transformed the data into log and first differencing and reconducted the DF test and found all the variables became stationary. Therefore, the dependent and independent variables are at I(1) which fulfills the conditions of ARDL model. Hence, we can reject the null hypothesis of unit root.



Source: Author's estimation based on NSO data

4.2 Optimal Lag Selection Criteria

The study found optimal lag based on AIC (Akaike Information Criteria) is ARDL (2,0,3) but as we lose the degrees of freedom hence, the study restraint maximum lag to 2 and found ARDL (2,0,2) regression as the best lag.

4.3 Results of ARDL Model

ARDL (2,0,2) regression						
Sample:	1972	-	2022	Number of obs	=	51
				F(6, 44)	=	1182.24
				Prob > F	=	0.0000
				R-squared	=	0.8738
				Adj R-squared	=	0.8730
				Root MSE	=	0.0391
Log likelihood	=	96.716521				
lagriGVA	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
lagriGVA						
L1.	.4147289	.1377101	3.01	0.004	.1371924	.6922653
L2.	.3895376	.1436358	2.71	0.010	.1000585	.6790166
1GCF_PubSec	.0442163	.0268429	1.65	0.107	-.009882	.0983145
1GCF_PvtSec						
--.	.1098245	.0378144	2.90	0.006	.0336145	.1860345
L1.	-.0249809	.0449145	-0.56	0.581	-.1155001	.0655383
L2.	-.0718804	.0414433	-1.73	0.090	-.1554038	.0116431
_cons	2.20853	1.42463	1.55	0.128	-.6626235	5.079684

Source: Authors' estimation

Table 3: Results of ARDL model

Table 3 shows the results of ARDL (2 0 2) regression model. The p-value is highly significant at 1 percent significance level and adjusted R-square is 0.873 which clearly shows that the independent variables are 87 percent impacting the dependent variable. From the table, it has been observed that the Lagged variables - L1 (t-1) and L2 (t-2) of the dependent variable itself i.e. share of agriculture in India's total GVA is highly significant at 5 percent significance level and the coefficients reveal that with increase in the share of agriculture outputs in total GVA in (t-1) and (t-2) periods, the total capital formation in agricultural sector will raise by 41 percent and 39 percent respectively. The gross capital formation by the private sector in the current year and 2 periods earlier (L2) are highly significant at 5 percent significance level. The result shows that if the private investment in the agricultural sector increases by Rs. 1 crore in the current

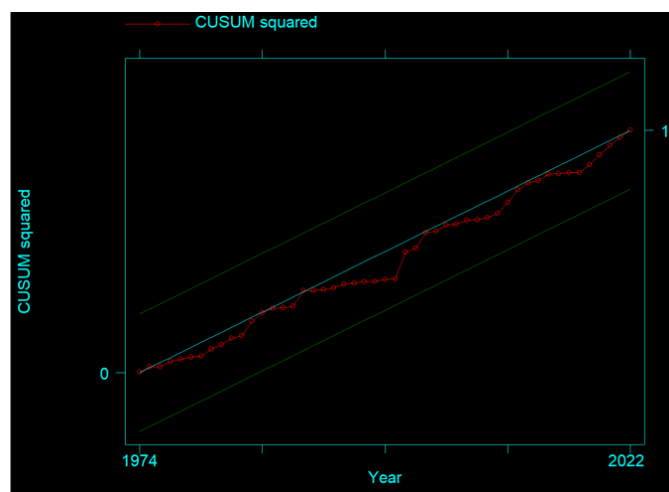
year and 2 years back then share of agricultural and allied sector GVA in total GVA will increase by 11 percent and 7.2 percent respectively. However, the log of gross capital formation by public sector in agricultural production and intercept value shows insignificant as since the economic reform of 1991 and the consequent privatization, the private investment in agricultural and allied sector has increased and hence, private gross capital formation shows significant results.

4.4 Bound Test for Cointegration

The study conducted bound test (Pesaran-Shin-Smith, 2001) to find the cointegration between the dependent and independent variables and the result shows that the value of F-statistic ($F = 1.604$) is lower than the critical values found hence, there is no long-term relationship between the share of agricultural GVA and lagged values of agricultural GVA and private investment and their lagged values.

4.5 Diagnostic Testing

To check whether there is any autocorrelation in the variables, the study conducted Durbin-Watson Test and found the d-statistics is more than 2 and hence, serial correlation has been found. Then the study run Breusch-Godfrey LM test (at lags 2) to validate the serial correlation in the error terms and found that we cannot reject the null hypothesis of no serial correlation as the $\text{Prob} > \chi^2 = 0.2395$. Afterwards the study tested for heteroscedasticity of the error terms by conducting the White test (Cameron & Trivedi's decomposition of IM-test) and found that $\text{Prob} > \chi^2 = 0.1541$, hence, we cannot reject the null hypothesis of homoscedasticity. Finally, the study checked Cumulative Sum (CUSUM and CUSUM) test to estimate the stability of beta coefficients in the dynamic regression model as shown in $y = X\beta + \varepsilon$ form. CUSUM squared test reflects the structural break in the data and the result (Figure 5) clearly indicates that the values are lying within the lower and upper limit and hence, there is no structural break.



Source: Authors' estimation

Figure 5: Cusum Squared Test

5. CONCLUSION AND RECOMMENDATIONS

Indian agricultural sector plays a major role in country's economic growth and development. It has been observed from trend analysis that in the post reform period both public and private capital investments in agricultural and allied sectors have risen manifold, but the sector's contribution was drifting around 3 percent. The present study investigated the effects of both public and private capital formations on the share of agricultural Gross Value Added using ARDL model. The study reveals that ARDL (2 0 2) is the optimal lagged model where the two lagged values of the dependent variable i.e., share of agriculture in total

GVA and 2 lagged values of private gross capital formations significantly and positively influenced the agricultural growth while public gross capital formations show insignificant. The study suggest that government should increase public investment in agricultural and allied sector in irrigation and technological facilities, providing subsidies, hybrid seeds, education, and rural development to enhance the agricultural productivity and sustainability.

6. LIMITATIONS AND FUTURE SCOPE OF THE STUDY

The study is not free from limitations as the present study aims to investigate the impact of public and private investments on agricultural growth by using the lagged values of both share of agricultural GVA and public and private capital formations but didn't covered the State-wise analysis as well as the factors which impacts the public and private investments. The future research can cover both the aspects.

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